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Optimization of time/temperature for dehydration of perishable and semi-perishable commodities

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ABSTRACT:
The processing of fruits and vegetables in Pakistan is less than 4% of the total production and leading to enormous post-harvest losses ranging from 40-50%. The objective of current study was to optimize the condition for dehydration of perishables**.** Onion, potato and apricot were for dehydrated by applying different time/temperature combination. The preparatory operations foe these commodities were also optimized to understand their effect on final product. The product quality parameters like re-hydration time and ratio, moisture, water activity and color were determined. The mechanical peeling was observed to be better peeling for potato as the peeling losses were less in that case. The higher dehydration ratio of the product results in lower product yield. The highest moisture content (16.10%) was observed in apricot while lowest in case of potato (5.95%). The onions have higher re-hydration ratio in lesser time while potatoes dehydrated at higher temperature more re-hydration ratio. The water activity of the dehydrated commodities was lower than 0.50 which is considered to best for extended shelf life. The color of products was also affect by the preparatory operation and the dehydration conditions. The findings may be applied to dehydrate the fruits and vegetables in order to curtail the post harvest losses and increasing the value addition.

Key Words: Dehydration, temperature, time, re-hydration ratio, water activity

INTRODUCTION

Food preservation is the process of treating and handling food in such a way as to stop or greatly slow down spoilage to prevent food borne illness while maintaining nutritional value, texture and flavor [1] Food preservation history is about 100000 years old. Man used the back of cave to store dried and roasted food since Old Stone Age before 15000 BC. Drying fish and boiling of food discovered in middles stone age. Sun drying and air were the oldest method for drying of food items. The deterioration and spoilage in semi-perishable (potatoes, onion) and perishables (fruits, vegetables) foods result from physical factors, pests, autolysis, microorganisms or a combination of them. Certain chemical and biochemical reaction catalyzed by enzymes during ripening process of fruits and vegetables can lead to spoilage, if not controlled [2]. Dehydration is one of the preservation methods that involve removal of biologically active water in order to reduce the growth of microorganism. An effective approach to Dehydrate and preserve the perishable goods such as fruits and vegetables is drying at low temperature so that the food should remain preserved in its natural texture [3]. It is estimated that 15-20% of the total production of fruits and vegetables i.e. about 250,000 to 300,000 tons can be used for dehydration annually [4].

The Onion (*allium cepa* L.) belongs to the family Amaryllidacease originated in Afghanistan. Onion have been cultivated and used as food throughout history. Potatoes were introduced in Indo-Pak subcontinent by Major Young who cultivated it first time in Dheradun in 19th century. According to Dr Anisole it was cultivated in hills and plains in 1839. Dehydrated food products are more suitable and economical than other processed foods .The main advantages of dehydrated food describe by Desrosier [5] are; concentrated than any other preserved form of foods, light in weight, require less storage space, cost effective and easy to store. The critical factors in maintaining the quality and shelf life of dehydrated food product are; quality of raw product, mechanical damage, primary processing and packaging.

In Drying, like other methods of preservation can result in loss of some nutrients. The loss of thiamine, riboflavin and niacin is observed during blanching but fairly retained if water used to dehydrate is also consumed and some minerals may loss. For best retention of nutrients in dried foods, store in cool, dark, dry place and use with in a year [6]. Commercial dehydration of vegetables was initiated by United States during American civil war but due to poor quality of product industry decline sharply but after World War II Dehydration industry thrived [1].

Pakistan though not a well developed country in dehydration process but the need of dehydrated fruits and vegetables may be necessary Hard Areas and in situations where the transportation of fresh food products is not very easy job and is thus spoiled before reaching the consumer destination. The present project was designed to optimize the processing conditions i.e. temperature/time for the dehydration of perishables (onion, potato and apricot).

MATERIALS AND METHODS

The present studies were conducted to find out the optimized conditions (temp and time) for onions, potatoes and apricots dehydration in cabinet drier. Fresh onions, potatoes and apricots were purchased from local market Faisalabad for study.

Preparation of samples
The individual samples of onions, potato and apricots were prepared by following the steps of peeling, slicing, pitting, blanching and sulphiting. The blanching and sulphiting treatment were done for potato according to specification given in Table 1.

Trimmed and pitted apricots were dipped in 5 ppm citric acid solution for 5 minutes and one sample before steam blanching for 5 min was sulphited in 2ppm KMS solution for 25 min.

Sample tray loading for dehydration
Trays loading were done at the rate of 1/2 kg material /sq foot of tray immediately preparatory operations

Dehydration
The samples of onions, potatoes and apricots were dehydration by specifying the conditions of cabinet dryer as given in Table 2.

Packing and storage
Dehydrated samples were packed in sterilized polyethylene bags for studies by storing at room temperature.

Physical analysis
Peeling and trimming losses
The peeling and trimming losses in case of onion and potatoes were calculated according the method described by Awan [7]. The losses in apricots were due to the removal of pit.
Peeling, trimming or pitting losses =

$$\frac{\text{Wt of wastage}}{\text{Wt of sample}} \times 100$$

Peroxidase presence test
The effectiveness of blanching treatment checked by analyzing the samples for peroxidase as according to procedure described by Awan [7].

Dehydration ratio
The dehydration ratio was determined by using following formula given by Riaz and Ahmed [8].

$$\text{Dehydration ratio} = \frac{\text{Weight before drying}}{\text{Weight after drying}}$$

Re-hydration ratio and time
The re-hydration time and ratio for onion and potato were determined by following formula given by Riaz and Ahmed [8].

$$\text{Re-hydration ratio} = \frac{\text{Weight after re-hydration}}{\text{Weight before re-hydration}}$$

Moisture contents
The moisture content in fresh and dehydrated product was determined by following the method given in AOAC [9].

Water activity
The water activity of potatoes, onions and apricots were determined at 7 days interval by using the water activity meter according to method described by Cosenza *et al*. [10].

Color test
The color tests of all samples were carried out with color meter to find out any changes in color during storage.

Percent yield
The dehydrated percent yield of all samples were determined by following formula given by Riaz and Ahmed [8].

$$\%\ \text{Yield} = \frac{\text{Weight after drying}}{\text{Weight before drying}} \times 100$$

RESULTS AND DISCUSSIONS
The samples prepared for dehydration were subjected to physical analysis to determine the preparatory losses and later on the dehydrated samples were subjected to quality analysis to finalize the conditions for dehydration.

Preparatory operations losses
Peeling is done in processing of many fruits and vegetables to remove unwanted inedible material and to improve appearance of final product. Size reduction of fruits and vegetables increases the surface area to volume ratio which will increase the rate of dehydration. It also improves the eating quality and increase suitability of food for further processing. Slicing and dicing is more common in potatoes and flaking is for onions [11]. The results regarding losses during preparatory operations are given in Table 3. The peeling losses in onion were comparatively higher (6.47%) than the potatos (6.10%) as peeling in onion was done manually while in case of potato it was carried out by abrasive peeler (mechanical). It is evident from the earlier findings of Fellows [11] that peeling losses vary greatly depending upon the method of peeling as reported losses upto 25% depending upon peeling method and the products. Singh [1] reported peeling losses 15-19% for manual peeling while 18-28% for mechanical peeling. The peeling losses during current investigation were lower than these limits which indicate the efficiency of peeling. The average weight loss in apricot was 11% due to removal of central pit and losses in case of apricot are higher than onion and potato. Enzymatic browning is one of most devastating reaction for many exotics fruits and vegetables, it is estimated that over 50 % losses in fruits occur as a result of enzymatic browning [3]. Blanching in boiling water or under steam will not only inactivate enzymes but also stops all life processes, and destroys 90% microorganisms [12].

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Fruits are not normally heat blanched instead chemical are used without heat to inactivate oxidative enzymes. Ascorbic acid is frequently used by being dissolved in water or in citric acid solution, or 0.25% of SO² or equivalent sodium/potassium metabisulphate are used [1].

Table 1: Blanching and sulphiting treatment of the potatoes

Sample					
	Temperature	**Time**	**Method**	**Treatment**	**Dipping Time**
T_1	100°C	6 min	Hot water	4 ppm KMS	10 min
T_2	100°C	3 min	Hot water	2 ppm KMS	5 min

Table 2: Dehydration condition for onion, potato and apricot

Treatments	Onion		Potato		Apricot	
	Temperature	**Time**	**Temperature**	**Time**	**Temperature**	**Time**
T_1	50°C	9.5 hours	60°C	9.5 hours	60°C	11 hours
T_2	50°C	7.5 hours	50°C	9.5 hours	60°C	11 hours

Table 3: Samples preparatory losses (%) during peeling, slicing and pitting

Treatments	Onion	Potato	Apricot
T_1	6.28	6.20	12.00
T_2	6.66	6.00	10.00
Mean	**6.47**	**6.10**	**11.00**

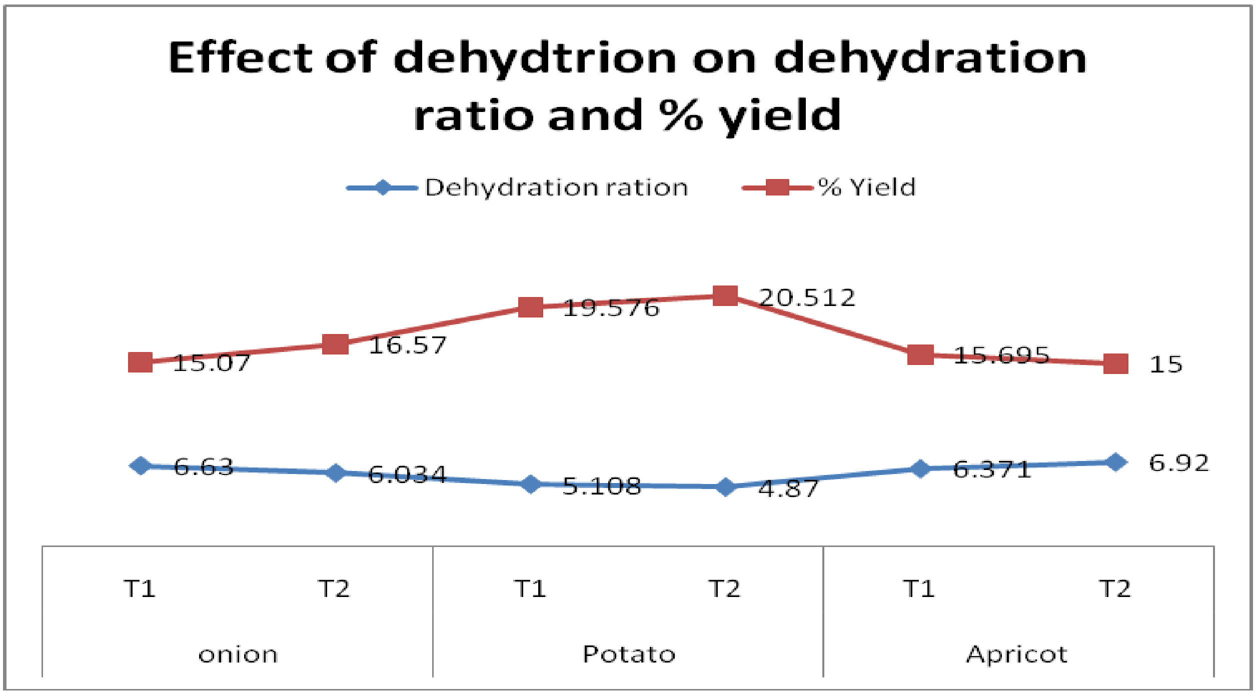

Figure 1: Effect of dehydration on dehydration ratio and yield

Table 4: Moisture contents (%) in dehydrated samples of onion, potato and apricot

Treatments	Onion	Potato	Apricot
T_1	4.70	5.36	16.30
T_2	8.70	6.54	15.90
Mean	**6.70**	**5.95**	**16.10**

Table 5: Re-hydration time and ratio of the dehydrated onion and potatoes

Product	Sample	Temperature	Time	Ratio
Onion	T_1	25	10	3.31
	T_2	25	10	3.15
Potatoes	T_1	25	6.5	2.85
	T_2	25	6.5	2.67
Potatoes	T_1	50	45	2.84
	T_2	50	45	2.67
Potatoes	T_1	100	20	2.85
	T_2	100	20	2.68

Table 6: Water activity of the dehydrated onion, potatoes and apricot

Product	Sample	Water activity	Temperature
Onion	T_1	0.288	33.7°C
	T_2	0.304	36.1°C
Potatoes	T_1	0.366	35.8°C
	T_2	0.448	35.8°C
Apricots	T_1	0.368	34.7°C
	T_2	0.413	35.6°C

Table 7: Color of the dehydrated onion, potatoes and apricot

Product	Sample	Color (CTn)
Onion	T_1	104
	T_2	148
Potatoes	T_1	107
	T_2	139
Apricots	T_1	114
	T_2	106

Dehydration ratio and yield

The dehydration ratio was calculated after the dehydration of the samples. The results regarding the dehydration ratio and yield are given in Fig. 1. It is evident from results that more the dehydration ratio will result in lesser yield of the product. Changes in temperature, drying time and water contents affect the dehydration ratio. In onions T_1 was dried for more time (9.5Hr) to attain less moisture content (4-5%) and better physical shape (very crisp) so its dehydration ratio is higher (6.63) as compared to T_2 which was dried for less time (7.5Hr) to final moisture of 8-9% with lower dehydration ratio (6.03). On the other side the T_1 has lesser dehydration yield (15.07%) as compare to yield of T_2 (16.57%). The potatoes sample T_1 was dried at higher temperature (60°C) as compare to T_2 which was dried at 50°C due to the reason that T_1 has absorbed extra water during blanching and sulphiting stage and need extra temperature to reduce the moisture content to 5-7% for desired brittle product. Therefore, potato sample T_1 has more dehydration ratio (5.10) and lesser yield (19.57%) than the dehydration ratio (4.87) of sample which was blanched for a lesser time (T_2) and has higher product yield (20.51%).

In case of apricot sample T_1 was dipped 25 min for sulphiting which resulted into more water absorption. Although drying time and temperature was same for both samples and as a result T_1 has lesser dehydration ratio (6.37) and higher yield (15.69%) as compare to T_2 which has higher dehydration ratio (6.92) and lower yield (15.00).

Moisture content of dehydrated products

The moisture content of food products plays an important role in determining shelf life of the commodities. The storage temperature and relative humidity of the storage environment greatly influence the shelf life. The onions samples T_1 and T_2 were dried at same temperature but due to variation in drying time moisture contents of the samples are different. The moisture content in T_1 were lower (4.70%) because of longer drying time to get very crispy end product while T_2 has higher moisture (8.70%) as it was subject for shorter time to drying temperature to get crispy end

product. The potatoes were dried at two different temperatures but exposure time was same. The sample T_1 was subjected to higher drying temperature (60°C) while T_2 was subjected to drying temperature of 50°C. The T_1 has lower moisture content (5.36%) due to its exposure to higher temperature while T_2 was dried at lower temperature and the product has higher final moisture contents (6.54%). The drying condition for apricot samples were same but the only difference was in samples preparation as T_1 was dipped in KMS solution for 25 minutes and as a result its has slightly higher moisture content (16.30) than T_2 having 15.90% moisture. The results of study are in line with Singh [1] who suggest final moisture content in dehydrated onion (4-6%), potatoes (8-12%) and apricot (15-20%).

Re-hydration time and ratio of the dehydrated products

The dehydrated products are rehydrated before using them so the tome required and the level to which they rehydrated are the most important factors affecting the dehydration. The re-hydration ratio of onions and potatoes were determined but that was not required for apricots as it is consumed in dehydrated form. The samples of onions T_1 and T_2 were rehydrated in normal water (25°C) only for 10 min while time for re-hydration of potatoes samples T_1 and T_2 in normal water (25°C) was much higher (6.5hr) which reduce in hot (50°C) and boiling water (100°C) to 45 and 20 minutes respectively as he depicted in Table 5. Physical condition of the product (crisp, brittle) affect time to rehydrate and re-hydration ratio is inversely proportional to the moisture contents available in final dehydrated product. Lesser the moisture content in the final products more will be the re-hydration ratio as depicted in Table 5. The results are in line with Eisenhardt *et al*. [13] who stated that dehydrated vegetables (potatoes and carrots) take longer time (20-30 minutes) to rehydrate in boiling water.

Water activity of dehydrated products

The water activity of the food products play an important role in determining the spoilage microorganism as different microorganism grow at different water activity. Any food product having water activity below 0.60 is assumed to have shelf life more than 1 year. Lesser the water activity more will be the shelf life of product. The water activity of onions, potatoes and apricots samples varies between 0.288 to 0.448 as indicated in Table 6. It is evident from results that products water activity is lower to support the growth of microorganism and thus have extended shelf life.

Color of dehydrated products

The color is an important product characteristic determining the acceptability of the product as the consumer eats by his eyes. Color test was performed with color meter which uses two standard 54 CTn (dark shade) and 151CTn (light shade). The onion sample T_1 has darker color (CTn148) as subjected to drying temperature for a longer time while T_2 has light color (CTn104) as indicated in Table 7. Similarly the potato sample subject to higher temperature (60°C) has darker color (CTn107) while the product dehydrated at lower temperature (50°C) has lighter color (CTn107). The apricot sample dipped in KMS solution has lighter color (CTn114) while sample without sulphiting have darker color (CTn106)

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